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11/13/97

Attorney's Docket No. 002240.P048 **Patent**

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SIR: Transmitted herewith for filing is the **nonprovisional patent application** of

Inventor(s): Peter L. Froeberg

For: EXTENSIBLE GPS RECEIVER SYSTEM
(Title)

Enclosed are:

- X Twelve (12) sheet(s) of Drawings.
- X An Assignment of the invention to ____________.
- X Assignment Cover Sheet Form PTO-1595.
- X A Declaration and Power of Attorney (X signed/ ____ unsigned).
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Total Claims:	13	- 20	* 0	x 11	$	x 22	$ 0
Indep. Claims:	3	- 3	* 0	x 41	$	x 82	$ 0
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				TOTAL	$	TOTAL	$ 790

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11/13/97
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X Send all correspondence to the undersigned at BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP, 12400 Wilshire Boulevard, Seventh Floor, Los Angeles, California 90025, and direct all telephone calls to the undersigned at (408) 720-8598.

Respectfully submitted,

BLAKELY SOKOLOFF TAYLOR & ZAFMAN LLP

Date: November 13, 1997

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(LJV/cak (10/01/97)

002240.P048 **PATENT**

UNITED STATES PATENT APPLICATION

FOR

EXTENSIBLE GPS RECEIVER SYSTEM

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(Signature of person mailing paper or fee) *Date*

EXTENSIBLE GPS RECEIVER SYSTEM

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to a mechanism for processing positioning signals such as those received from the Global Positioning System (GPS).

ART BACKGROUND

The global positioning system (GPS) has become extremely popular for a number of applications. GPS receivers are now incorporated into a variety of systems including consumer electronic systems in which the location information or time information provided by GPS supplements the other information provided by the system. Thus, more and more industries are realizing the advantages that GPS can provide.

Typically, when a customer, such as an original equipment manufacturer (OEM) develops a particular application of GPS, the GPS manufacturer generates the application code in accordance with the customer's specification. The GPS manufacturer designs and codes the user application of GPS, as the processing performed by the GPS receiver has strict timing and processing requirements that cannot be disturbed by other processing such as the user application processing. Unless carefully written, the execution of customer code can conflict with the GPS processing code. In addition, there is the danger of the user code overriding sections of memory

containing the GPS processing code or GPS data used in processing. Thus, the GPS manufacturer cognizant of these restrictions carefully develops the user application code for a particular customer. This is a time consuming and costly process. It is therefore desirable to develop a system that insulates the GPS processing portion and data from the user application portion such that the user application portion has access to the positioning data generated by the GPS processing portion without the concern that the user application portion will corrupt the GPS processing portion and data of the receiver.

SUMMARY OF THE INVENTION

The apparatus and method of the present invention provides a processing system in which the processor is coupled to a Global Positioning System (GPS) receiver circuitry that receives positioning signals and, in accordance with well known GPS processing techniques, generates the positioning data for access by a user application process executing on the same processor. A firewall is established between the user application process and the GPS process. The firewall prevents the user application process from conflicting with time critical processing by the GPS process and further prevents the user application process from overriding the memory areas allocated to the GPS process.

BRIEF DESCRIPTION OF THE DRAWINGS

The objects, features and advantages of the present invention will be apparent to one skilled in the art from the following detailed description in which:

Figure 1 is a simplified block diagram of one embodiment of the system of the present invention.

Figure 2 is a block diagram illustrating the structure of the processes in accordance with the teachings of the present invention.

Figures 3a and 3b illustrate one class of GPS objects in accordance with the teachings of the present invention.

Figures 4a, 4b, 4c, 4d, 4e, 4f and 4g illustrate another class of GPS objects in accordance with the teachings of the present invention.

Figures 5a and **5b** illustrate a class of GPS objects in accordance with the teachings of the present invention.

DETAILED DESCRIPTION

In the following description, for purposes of explanation, numerous details are set forth in order to provide a thorough understanding of the present invention. However, it will be apparent to one skilled in the art that these specific details are not required in order to practice the present invention. In other instances well known electrical structures and circuits are shown in block diagram form in order not to obscure the present invention unnecessarily.

The system of the present invention provides a user configurable Global Position System (GPS) receiver system in which the user application processing does not interfere with time critical positioning processing. A simplified block diagram is shown in **Figure 1**. The system and methods of the present invention are described below with reference to a GPS receiver. However, it is contemplated that the present invention can be implemented in a variety of positioning system receivers including GLONASS, Loran-C and Pseudo-lite receivers.

Referring to **Figure 1**, a GPS antenna and corresponding receiver circuitry **10** is connected to processor **15** via bus **20**. The processor **15** interacts with the GPS hardware such as the correlators, voltage control oscillator (VCO's) and the like, located in receiver **10** to acquire and track GPS signals transmitted by satellites. Thus, GPS receiver **10** receives GPS signals from satellites under the control of processor **15** acquires and tracks the satellites in order to receive the positioning signals. The processor **15** further processes the positioning signals to generate positioning data. Typically, the positioning data includes a time, angular and distance measurements. The specific data generated can vary according to implementation and is well

known in the art. Furthermore, the control functions performed by the processor to acquire and track signals are well known in the art and will not be discussed further herein.

As is well known in the art, positioning signal processing is time critical in nature. Therefore, delays in processing the positioning signals can cause significant error in the computations. Processor **15** not only performs position signal processing, but also performs user application processing. The code and data for the user application as well as the positioning signal code and data are preferably stored in memory **25**, which is coupled to processor **15** via bus **20**. It is contemplated that memory **25** may also be coupled to processor **15** through a separate bus (not shown). In addition, the system includes a variety of I/O devices, such as GPS antenna/receiver **10**, a display **30** and at least one user input device input device **35**, such as a keyboard or mouse. The use of these I/O devices is programmable according to the user application.

Figure 2 is a block diagram illustrating the process structure that enables the positioning signal processing to be performed without encumbrance by the user application processing. The processor is controlled by an operating system which receives the instructions of the executing processes and controls the processor accordingly.

Although not limited as such, in the present embodiment it is preferred that a real-time operating system **205** is used to address the time critical nature of the satellite signal processing. The operating system **205** is connected to the code **210** used to control the input/output devices including the GPS receiver. One example of a real-time operating system is the Vx Works® embedded operating system marketed by WindRiver Systems. The processor processes the satellite signals in accordance with the

GPS process **215**. Thus, GPS process **215** interacts in the real-time manner with the real-time operating system **205** to receive positioning signals through I/O control 210 and controls the GPS receiver circuitry through I/O control **210** to accurately acquire and track the satellite signals.

As noted above it is desirable to enable the user to configure the system for the user's particular application. Therefore, in order to provide this capability, a firewall **220** is established between the GPS process **215**, real-time operating system **205**, and the user application **225**.

In the present embodiment a virtual machine is used **230** to provide a level of protection from a user application program interfering with the data utilized in the GPS process **215**. For example, the virtual machine **230** prohibits the user application process **225** from specifically accessing or corrupting a particular memory location not previously allocated to that application as the virtual machine acquires the application to address a particular memory location using a virtual address. In addition, the application process must have the privilege of accessing that particular address. Thus, virtual machine **230** provides one level of the firewall **250**.

A virtual machine is a software computer that executes programs that have been compiled into byte code. As noted above, the virtual machine separates the hardware and system software from the application software. Thus, system independent applications can be developed in any language that has a compiler that generates the virtual machine byte code. Applications once complied with byte code can be downloaded and executed as any processor that executes a virtual machine. One such virtual machine, is the Java Virtual Machine, by Sunsoft, Mountain View, California.

The firewall **250** further is required to prohibit the user application **225** from interfering with the time critical processing of the GPS process **215**.

In order to protect against this potential problem, the user application processes, as executed by virtual machine **230**, are set to a priority that is lower than the priority of the GPS process **215**. For example, this is done by setting the priority of the GPS process to the highest priority in the operating system **205**. Thus, any other process, such as the user application process will run at a lower priority, thus insuring that the GPS process **215** executes in a timely manner.

Continuing reference with **Figure 2**, in the present embodiment, an application programming interface (API) **240** is provided to simplify the user task of developing the user application. The API **240** preferably includes a number of functions that are accessible by the user application. In the present embodiment, the system is programmed using object oriented technology, such as C++; alternately the Java language can be used. **Figures 3a** and **3b** illustrate the Java objects for getting information to perform routing processes. **Figures 4a - 4g** illustrate objects used to acquire time information from GPS signals. **Figure 5a** is illustrative of GPSfix objects that can be used to get location information, i.e., a "fix". In the present embodiment, it is preferred that the GPSfix classes are constructed as class hardwarefix or simfix, wherein class hardwarefix , when initialized, includes communication between the class and the hardware. Furthermore, the object created receives data from the GPS hardware receiver. Simfix is a class of superclass GPSfix that users can instantiate to obtain a simulated GPS fix. When the class is initialized (e.g., the first time it is used), a simulator is started that propagates meaningful positions over time. Furthermore, the class includes methods to deal with simulation, e.g., defining regions and dynamics of simulated data. Simfix is used to provide an applications developer with a realistic model of GPS data.

It is readily apparent that a system developer can provide a variety of objects to address potential user applications. Thus, the user in this embodiment is further isolated from the operating system **205** through the API **240**. The resulting system provides a system readily adaptable by a variety of users for a variety of applications without the concern of interference of the time critical GPS processing.

The invention has been described in conjunction with the preferred embodiment. It is evident that numerous, alternatives, modifications, variations, and uses will be apparent to those skilled in the art in light of the foregoing description.

CLAIMS

What is claimed is:

1. A positioning system comprising:

a receiver configured to receive positioning signals;

a processor configure to process the positioning signals in a real time manner to generate positioning data;

user application code executed by the processor, said application code configured to access the positioning data;

a firewall established between the processor and the user application code, said firewall configured to prevent the user application code from corrupting positioning data and enables the processor to process the positioning signals in real time without interference by the user application code.

2. The positioning system as set forth in claim 1, further comprising an application programming interface (API), said API configured to access the positioning data as instructed by the user application code.

3. The positioning system as set forth in claim 2, wherein the API comprises a plurality of objects.

4. The positioning system as set forth in claim 1, wherein the processor executes a real time operating system (RTOS).

5. The positioning system as set forth in claim 1, wherein the firewall comprises a virtual machine.

6. The positioning system as set forth in claim 1 wherein the processor comprises positioning code executed by the processor and the firewall comprises setting the positioning code to a higher priority than the user application code.

7. In a positioning system, a method for processing positioning signals comprising the steps of:

receiving positioning signals;

processing the positioning signals in a real time manner to generate positioning data;

accessing the positioning data through a firewall that prevents an access from corrupting positioning data and interfering with the processing of the positioning signals;

processing the positioning data to generate user application data.

8. The method as set forth in claim 7, wherein the step of processing the positioning signals is performed using a real time operating system (RTOS).

9. The method as set forth in claim 7, wherein the firewall comprises a virtual machine, said step of accessing comprising the steps of:

issuing instructions to the virtual machine;

said virtual machine receiving the issued instructions and performing the access in accordance with the issued instruction.

10. The method as set forth in claim 7, wherein the firewall comprises the steps of processing the positioning signals at a higher priority than the accessing and processing the positioning data.

11. A computer readable medium containing executable instructions which, when executed in a processing system, causes the system to perform steps for processing positioning information, comprising:

receiving positioning signals;

processing the positioning signals in a real time manner to generate positioning data;

accessing the positioning data through a firewall that prevents an access from corrupting positioning data and interfering with the processing of the positioning signals; and

processing the positioning data to generate user application data.

12. The computer readable medium as set forth in claim 11, wherein the instructions further comprise a virtual machine, said step of accessing comprising the steps of:

issuing instructions to the virtual machine; and

said virtual machine receiving the issued instructions and performing the access in accordance with the issued instruction.

13. The computer readable medium as set forth in claim 11, wherein the step of accessing comprises accessing the positioning data at a lower priority than processing the positioning signals.

<u>ABSTRACT</u>

An extensible Global Positioning System (GPS) receiver system is described. The receiver system isolates user application processing from time critical GPS acquisition and tracking processing in order to insure that GPS acquisition and tracking processing is timely performed. Thus user application processing can be developed without concern of conflict with GPS acquisition and tracking processing.

Attorney's Docket No.: 02240.P048 Patent

DECLARATION FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below, next to my name.

I believe I am the original, first, and sole inventor (if only one name is listed below) or an original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Extensible GPS Receiver System

the specification of which

XX is attached hereto.
______ was filed on ____________________ as
United States Application Number ____________
or PCT International Application Number ____________
and was amended on ____________________.
(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred to above. I do not know and do not believe that the claimed invention was ever known or used in the United States of America before my invention thereof, or patented or described in any printed publication in any country before my invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, and that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months (for a utility patent application) or six months (for a design patent application) prior to this application.

I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d), of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s) Priority Claimed

(Number)	(Country)	(Day/Month/Year Filed)	Yes	No
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No

I hereby claim the benefit under title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below

(Application Number)	Filing Date
(Application Number)	Filing Date

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Number)	Filing Date	(Status -- patented, pending, abandoned)
(Application Number)	Filing Date	(Status -- patented, pending, abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full Name of Sole/First Inventor Peter L. Froeberg

Inventor's Signature *Peter L. Froeberg* Date *Nov 13, 1997*

Residence Cupertino, California (City, State) Citizenship USA (Country)

Post Office Address 22487 Santa Paula Avenue
Cupertino, CA 95014

Title 37, Code of Federal Regulations, Section 1.56
Duty to Disclose Information Material to Patentability

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclosure information exists with respect to each pending claim until the claim is cancelled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is cancelled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclosure all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine:

(1) Prior art cited in search reports of a foreign patent office in a counterpart application, and

(2) The closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentably defines, to make sure that any material information contained therein is disclosed to the Office.

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made or record in the application, and

(1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or

(2) It refutes, or is inconsistent with, a position the applicant takes in:

(i) Opposing an argument of unpatentability relied on by the Office, or

(ii) Asserting an argument of patentability.

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability.

(c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are:

(1) Each inventor named in the application;

(2) Each attorney or agent who prepares or prosecutes the application; and

(3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application.

(d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor.

Attorney's Docket No.: 02240.P048 Patent

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of:	)
Peter L. Froeberg	)
Application Number: not yet assigned	)
Filed: Herewith	)
For: EXTENSIBLE GPS RECEIVER SYSTEM	)

Assistant Commissioner for Patents
Washington, D.C. 20231

POWER OF ATTORNEY

Trimble Navigation Limited
(Name of Assignee)
("assignee"), a California corporation having a place of
(State of Incorporation)
business at 645 North Mary Avenue, Sunnyvale, California 94086,
(Address)

certifies that to the best of assignee's knowledge and belief it is the assignee of the entire right, title, and interest in and to the above-referenced patent application and represents that the undersigned is a representative authorized and empowered to sign on behalf of the assignee.

Assignee has reviewed the assignment document (copy attached) that evidences the placement of title in the assignee and upon information and belief that the assignment document is being forwarded to the U.S. Patent and Trademark Office for recordation

Pursuant to 37 C.F.R. §§ 3.73 and 3.71, the assignee hereby appoints Aloysius T. C. AuYeung, Reg. No. 35,432; William Thomas Babbitt, Reg. No. 39,591; Jordan Michael Becker, Reg. No. 39,602; Bradley J. Bereznak, Reg. No. 33,474; Michael A. Bernadicou, Reg. No. 35,934; Roger W. Blakely, Jr., Reg. No. 25,831; Gregory D. Caldwell, Reg. No. 39,926; Kent M. Chen, Reg. No. 39,630; Lawrence M. Cho, Reg. No. 39,942; Thomas M. Coester, Reg. No. 39,637; Roland B. Cortes, Reg. No. 39,152; William Donald Davis, Reg. No. 38,428; Michael Anthony DeSanctis, Reg. No. 39,957; Daniel M. De Vos, Reg. No. 37,813; Karen L. Feisthamel, Reg. No. 40,264; James Y. Go, Reg. No. P-40,621; Tarek N. Fahmi, Reg. No. P-41,402; David R. Halvorson, Reg. No. 33,395; Eric Ho, Reg. No. 39,711; George W Hoover II, Reg. No. 32,992; Eric S. Hyman, Reg. No. 30,139; Dag H. Johansen, Reg. No. 36,172; Stephen L. King, Reg. No. 19,180; Dolly M. Lee, Reg. No. 39,742; Michael J. Mallie, Reg. No. 36,591; Kimberley G. Nobles, Reg. No. 38,255; Ronald W. Reagin, Reg. No. 20,340; James H. Salter, Reg. No. 35,668; William W. Schaal, Reg. No. 39,018; James C. Scheller, Reg. No. 31,195;

Charles E. Shemwell, Reg. No. 40,171; Maria McCormack Sobrino, Reg. No. 31,639; Stanley W. Sokoloff, Reg. No. 25,128; Allan T. Sponseller, Reg. No. 38,318; Steven R. Sponseller, Reg. No. 39,384; Edwin H. Taylor, Reg. No. 25,129; Lester J. Vincent, Reg. No. 31,460; John Patrick Ward, Reg. No. 40,216; Ben J. Yorks, Reg. No. 33,609; and Norman Zafman, Reg. No. 26,250; my attorneys; and Robert Andrew Diehl, Reg. No. P-40,992; Sharmini Nathan Green, Reg. No. P-41,410; Thomas A. Hassing, Reg. No. 36,159; Edwin A. Sloane, Reg. No. 34,728; and Judith A. Szepesi, Reg. No. 39,393; my patent agents, of BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP, with offices located at 12400 Wilshire Boulevard, 7th Floor, Los Angeles, California 90025, telephone (310) 207-3800, with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith.

Pursuant to 37 C.F.R. § 3.71, the assignee hereby states that prosecution of the above-referenced patent application is to be conducted to the exclusion of the inventor(s).

Send all future correspondence to Maria McCormack Sobrino,

Reg. No. 31,639, Blakely, Sokoloff, Taylor, & Zafman LLP, 12400 Wilshire Boulevard, Seventh Floor, Los Angeles, California 90025, and direct all telephone calls to the same at (408) 720-8598.

Assignee of Interest: Trimble Navigation Limited
(Type or Print)

Dated: 11/13/97

By: James M. Janky

Name: James M. Janky
(Type or Print)

Title: Vice President, Intellectual Property
(Type or Print)

Address of Assignee of Interest:
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Sunnyvale, California 94086

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP

Dated: November 13, 1997

By Maria McCormack Sobrino

Name: Maria McCormack Sobrino
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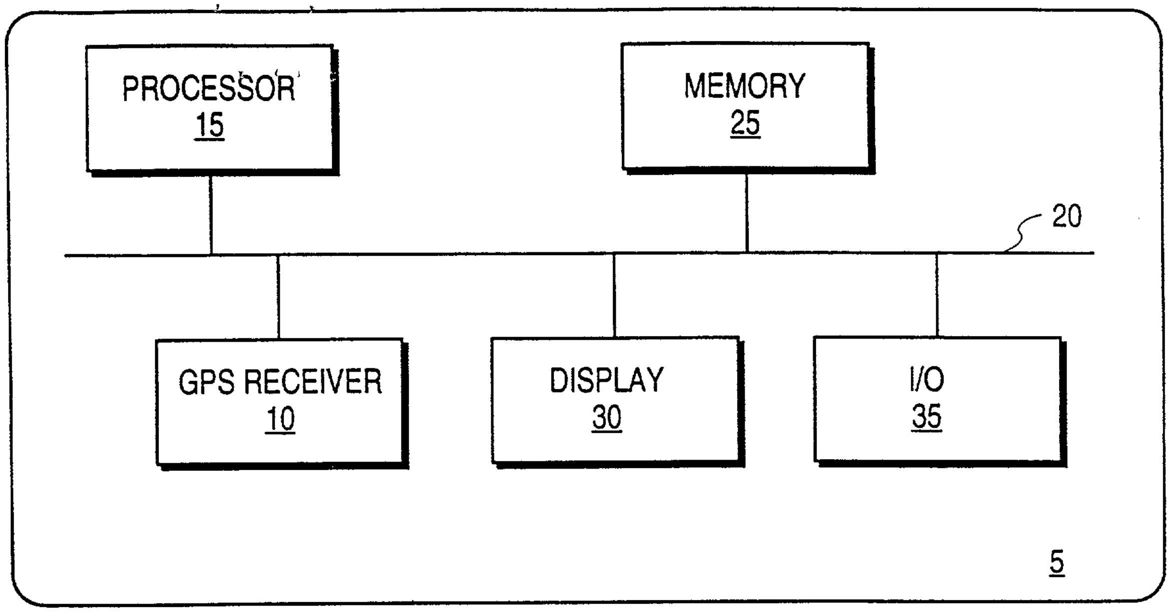
PROCESSOR
15
MEMORY
25
20
GPS RECEIVER
10
DISPLAY
30
I/O
35
5

FIG. 1

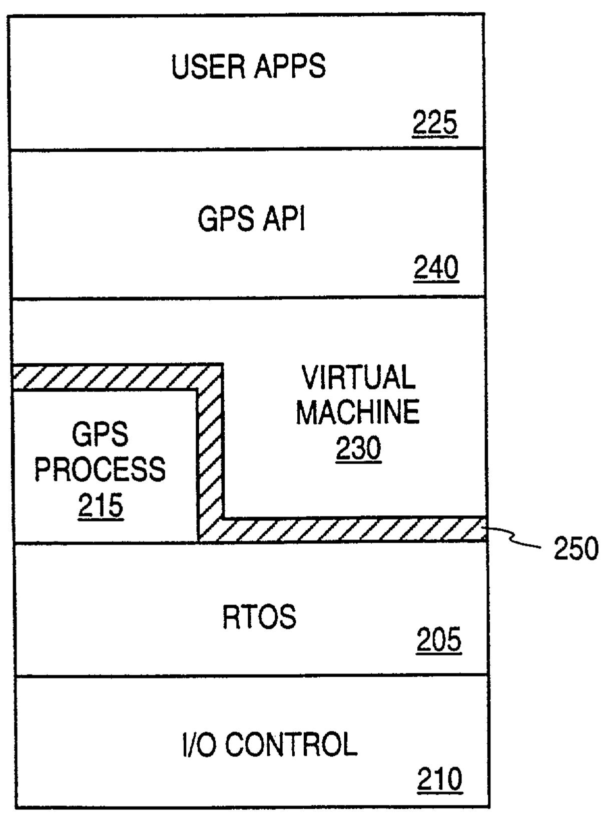
USER APPS
225
GPS API
240
GPS PROCESS
215
VIRTUAL MACHINE
230
250
RTOS
205
I/O CONTROL
210

FIG. 2

CLASS GPS.ROUTEPOINT	
METHODS	
-getLat	public double getLat ( )
-getLon	public double getLon ( )
-getTime	public int getTime ( )
-getRadius	public int getRadius ( )
-getEarlyThreshold	public int getEarlyThreshold ( )
-getLateThreshold	public int getLateThreshold ( )
-getDistance	public double getDistance ( )
-getIndex	public int getIndex ( )
-setTime	
-setRadius	public void setRadius (int radius)
-setEarlyThreshold	public void setEarlyThreshold (int early)
-setLateThreshold	public void setLateThreshold (int late)
-setDistance	public void setDistance (double distance)

FIG. 3a

CLASS GPS.ROUTEPOINT	
METHODS	
-setIndex	public void setIndex (int index)
-toString	public String toString ( ) **Overrides:** <u>toString</u> in class Object

FIG. 3b

CLASS GPS.GPSTIME	
VARIABLES	
-SECS_PER_WEEK	public static final int SECS_PER_WEEK
-SECS_PER_DAY	public static final int SECS_PER_DAY
-SECS_PER_HOUR	public static final int SECS_PER_HOUR
-SECS_PER_MINUTE	public static final int SECS_PER_MINUTE
-MINS_PER_HOUR	public static final int MINS_PER_HOUR
-HOURS_PER_DAY	public static final int HOURS_PER_DAY
-DAYS_PER_WEEK	public static final int DAYS_PER_WEEK

FIG. 4a

CLASS GPS.GPSTIME		
CONSTRUCTORS		
-GPStime	public GPStime ( )	Constructs a GPStime object with the current date and time
-GPStime	public GPStime (int yyyy, int m, int d)	Constructs a specific GPStime given only the date **Parameters:** yyyy - year (full year, e.g., 1996, *not* starting from 1900) m - month (1-12) d - day (1-31) **Throws:** IllegalArgumentException if yyyy/m/d h:min:ss.ss not a valid date/time
-GPStime	public GPStime (int yyyy, int m, int d, int h, int min, float s)	Constructs a specific GPStime given a date & time **Parameters:** yyyy - year (full year, e.g., 1996, *not* starting from 1900) h - hour (range 0-23) min - minute (range 0-59) s - second (range 0-59.999...) **Throws:** IllegalArgumentException if yyyy/m/d h:ss.ss not a valid date/time

FIG. 4b

CLASS GPS.GPSTIME		
CONSTRUCTORS, cont.		
-GPStime	public GPStime (short week_tag, float time_tag)	Constructs a specific GPStime given the GPS week/second tags. This method corrects for UTC leap seconds and performs GPS week rollover checking according to the current rollover threshold currently in effect **Parameters:** week_tag - GPS week number (range 0 to 1023) time_tag - Seconds into the GPS week (not adjusted for UTC)

FIG. 4c

CLASS GPS.GPSTIME		
METHODS		
-advanceDay	public void advanceDay (int n)	Advance by n days. For example. d.advanceDay(30) adds thirty days to d **Parameters:** n - the number of days by which to change this (n can be < 0)
-advanceSecond	public void advanceSecond (float n)	Advance the time by n 'seconds'. For example. d.advanceSecond(30) adds thirty seconds to d **Parameters:** n - the number of seconds by which to change this day (can be < 0)
-getSecond	public float getSecond ( )	Gets the second of the minute **Returns:** the second of the minute (range 0 to 59.999...)
-getMinute	public int getMinute ( )	Gets the minute of the hour **Returns:** the minute of the hour (range 0 to 59)
-getHour	public int getHour ( )	Gets the hour of the day **Returns:** the hour of the day (range 0 to 23)

FIG. 4d

CLASS GPS.GPSTIME		
METHODS cont.		
-getDay	public int getDay ( )	Gets the day of the month **Returns:** the day of the month (range 0 to 31, month dependent)
-getMonth	public int getMonth ( )	Gets the month **Returns:** the month (range 1 to 12)
-getYear	public int getYear ( )	Gets the year **Returns:** the year (counting from 0, *not* 1900)
-weekday	public int weekday ( )	Gets the weekday **Returns:** the weekday (0 = Sunday, 1 = Monday, ... , 6 = Saturday)
-daysBetween	public int daysBetween (GPStime b)	The number of days between this and GPStime parameter **Parameters:** b - any GPStime **Returns:** the number of days between this and GPStime parameter and b (> 0 if this day comes after b)

FIG. 4e

CLASS GPS.GPSTIME		
METHODS cont.		
-secsBetween	public double secsBetween (GPStime b)	The number of seconds between this and GPStime parameter **Parameters:** b - any GPStime **Returns:** the number of seconds between this and GPStime parameter and b (> 0 if this comes after b)
-getWeek_tag	public short getWeek_tag ( )	Get the GPS week_tag **Returns:** the GPSweek_tag value (aliased to lie from 0 - 1023)
-getTime_tag	public float getTime_tag ( )	Get the GPS time_tag **Returns:** the GPStime_tag value (offset from UTC by GPS leap seconds)
-convertGPStimetag	public void convertGPStimetag (short week_tag, float time_tag)	Set this GPStime to the GPS week/seconds tags. This method corrects for UTC leap seconds and performs GPS week rollover according to the current rollover threshold currently in effect **Parameters:** week_tag - GPS week number (range 0 to 1023) time_tag - Seconds into the GPS week (not adjusted for UTC)

FIG. 4f

CLASS GPS.GPSTIME		
METHODS cont.		
-toString	public String toString ( )	A string representation of the day **Returns:** a string representation of the GPS date and time **Overrides:** toString in class Object
-DurationString	public static String DurationString (int dt)	A string representation of a duration in seconds **Parameters:** dt - Delta time in seconds **Returns:** a string representation of the delta seconds parameter
-toCalendar	public Calendar toCalendar ( )	Convert to Java Calendar object using the default Time zone and locale GPS seconds round to the nearest integer second
-clone	public Object clone ( )	Makes a bitewise copy of a GPStime object **Returns:** a bitewise copy of a GPStime object **Overrides:** clone in class Object
-main	public static void main (String args [ ])	

FIG. 4g

CLASS GPS.GPSFIX		
METHODS		
-clone	public Object clone ( )	Makes a bitwise copy of a GpsFix object **Returns:** a bitwise copy of a SimFix object TBD: sub-objects must also support cloning and be explicitly cloned here. **Overrides:** clone in class Object.
-getDGPSflag	public boolean getDGPSflag ( )	Get the Differential GPS status of the current fix. A TRUE value may be either 2D or 3D.
-GetLatitude	public double GetLatitude ( )	Get the latitude in degrees referenced to WGS-84 Positive values indicate northern hemisphere. Negative values indicate southern hemisphere.
-GetLongitude	public double GetLongitude ( )	Get the longitude in degrees referenced WGS-84 Negative values indicate western hemisphere. Positive values indicate eastern hemisphere.
-GetAltitudeMSL	public double GetAltitudeMSL ( )	Get the altitude in meters above the geoid (mean sea-level)
-getAltitudeWGS84	public double getAltitudeWGS84 ( )	Get the altitude in meters above the WGS-84 ellipsoid.
-getTimeTag	public float getTimeTag ( )	Get the GPS time tag as seconds within the GPS week.

FIG. 5a

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CLASS GPS.GPSFIX		
METHODS cont.		
-getWeekTag	public short getWeekTag ( )	Get the GPS week tag (0-1023) from the GPS epoch. This epoch is nominally Jan 6, 1980, but can be adjusted accordingly within the GPStime class.
-getTimeOfFix	public GPStime getTimeOfFix ( )	Return the UTC (leap-second corrected) time of current fix.
-AgeofFix	public double AgeOfFix ( )	Get the age of the current fix in seconds as compared to (GPS-corrected) system time.
-TimeSincePreviousFix	public float TimeSincePreviousFix (GpsFix prevfix)	Return the number of seconds between this fix and the specified (prior) fix.
-GetSpeed	public float GetSpeed ( )	Return the horizontal speed in meters per second.
-GetHeading	public float GetHeading ( )	Return the current "course" in degrees clockwise from the true north.
-GetVspeed	public float GetVspeed ( )	Return the vertical speed in meters per second.
-equals	public boolean equals (GpsFix f)	Return true if fixes are equal.
-print	public void print (String s)	
-print	public void print ( )	

FIG. 5b